Appendix A
Darrington Collaborative - SegelsenPilot Project Prescription and Implementation Plan

December 2016
Stewardship Forestry & Science

I. Project Overview

The Segelsen stewardship project isthe pilot project of the recently formed Darrington Collaborative on the Darrington Ranger District of the Mount Baker Snoqualmie National Forest (MBS). The Stewardship project has two components: a thinning project in the Segelsen area and a stream crossing upgrade project on Clear Creek. This document covers the thinning portion only. The stand is approximately 5 miles northwest of Darrington, west of the USFS 18 Road, just north of Cascade Creek.Only 65 acres of this stand will be treated with commercial thinning.

II. Goals and Objectives

The overall goal of this pilot project is to try different prescription approaches to build group understanding and learning regarding different management approaches that could be applied more broadly across the Darrington Ranger District. Below are the main objectives for the forest management portion of the project:

Ecological

1. Use variable density thinning to accelerate the development of old-forest characteristics and functions, including large trees with complex crowns, a multistory canopy, dead wood and decadence, a diverse plant community, and a patchy, variable structure that includes openings.
2. Minimize damage and disturbance to riparian areas and soils.

Social/ Economic

1. Provide work for local logging contractors and wood volume for local wood processing industries.
2. Provide revenue for aquatic restoration projects, including the Clear Creek stream crossing upgrades.

3. Develop common understanding of forest management approaches and their effects among collaborative members. Test different prescription and contracting approaches that have ecological benefits and can be replicated on larger projects.

III. Current Conditions

Location

The 113-acrestand is located in a portion of the north half of Township 33, Range 9, Section 33; and in a small portion of the south half of the southwest quarter of Section 28 in Skagit County, Washington. The stand is approximately 5 miles northwest of Darrington, west of the USFS 18 Road, just north of Cascade Creek. The land classification is AMA. Only 65 acres of the stand will be treated with commercial thinning.

Topography, climate, and soils

The Segelsen stand is located on a sloped bench, above and north of Cascade Creek,Elevation ranges from 1,950-2,150 feet. Winters are cool and rainy with some snow, and summers are drier and warm. Based on measurements between 1981 and 2010 at the Darrington Ranger Station, the area receives 81 inches of precipitation per year, including 24 inches of snow. Average high and low temperature in January are 43 are 29 degrees F, and are 80 and 51 degrees F in July. The terrain in the main, central portion the unit has gentle slopes (0-10%), while the eastern and southern portions havesteep slopes (40-70%), especially near Cascade Creekalong the southern edge (Figure 1). Slopes greater than 35% were excluded from the unit, except for a few short pitches that are less than 100' from flat ground.

Soils on the bench consist of gravelly silty loams derived from glacial till and other residuum. On slopes within the unit, soilsare considered stable, with rapid permeability where not shallowly underlain by bedrock. Soil in the small wetland within the unit is partially hydric, meaning that anaerobic conditions have reduced it chemically to clays and other minerals. The basement complex of schist and related metasedimentary rock outcrops in a few locations within the unit.

Vegetation

The Segelsenstand originated from clear-cutting, planting, and natural regeneration approximately 55 years ago. Itis a dense, structurally simple forest comprised of two forest types.The eastern and central portion of the unit, coving about 65% of the area, has a western hemlock-silver fir forest

typewith a minor component of Douglas-fir. Western redcedar, red alder, and black cottonwood are also significant in localized patches.Tree regeneration in the understory is sparse, with limited silver fir and western hemlock regeneration in shady conditions. Similarly, shrubs, forbs, and graminoids are sparse, and include sword fern, Alaska huckleberry, vine maple, red elderberry, and deer fern. Salmonberry and devil's club are found in ravines and moist microsites. The Plant Association for the silver fir-western hemlock forest typeis silver fir - Alaska huckleberry-sword fern (ABAM/VAAL-POMU, CFS231). Site index averages 94 (Wiley 1978, 50 year base age) in hemlock-silver fir dominated areas.

The western portion of the forest is dominated with Douglas-fir with some western hemlock as the aspect changes towards south-facing. Western redcedar, red alder, and black cottonwood are a minor component. The Plant Association for the Douglas-fir forest type is western hemlock-huckleberry-swordfern (TSHE/VAAL-POMU, CHS625). Site index averages118 (King 1966; Site Class II) in the Douglas-fir dominated areas.

Thirty stand exam/inventory and long-term monitoring plots were established throughout the Segelsen pilot project stand (Figure 1). Plots are $1/20^{th}$ acre fixed-area plots measuring all trees above breast height (4.5 feet from ground, DBH), with ground vegetation sampling, and sub-samples of tree heights, ages, diameter growth increment, and live crown also measured. See Tables 1 and 2and Figure 2 for tabular inventory results.

The stand averages 375 trees per acre (TPA), though forest composition varies across the stand. Western hemlock-silver fir-dominated areas in the east and central portion of the stand are denser with smaller diameter trees, while Douglas-fir-dominated areas are less dense with larger trees. Basal area (BA) averages 359 ft^2/acre, with higher BA in Douglas-fir dominated areas (Figs 3a & 3b). Quadratic mean diameter (QMD) is a calculation of the diameter of a tree with average basal area; QMD is 13.2" for the stand. The largest diameters are greater than 24 inches, with a 28.1" silver fir the largest tree measured. Average height is 97 feet, with the tallest trees (Douglas-firs) measuring over 140 feet.

Relative density is a measure of stand density compared to a theoretical maximum tree biomass for the forest type. We calculated both Curtis Relative Density, which is designed for Douglas-fir, as well as Stand Density Index (SDI) based relative density. We used a 585 max SDI for the Douglas-fir areas and an 800 max SDI for the hemlock-silver-fir areas. For the whole stand, Curtis RD is very

high (97), and SDI based RD using a max of 800 is 70%. At the plot level, relative densities for two-thirds of the plots are 60 or greater, indicating very dense conditions resulting in high rates of competitive mortality.

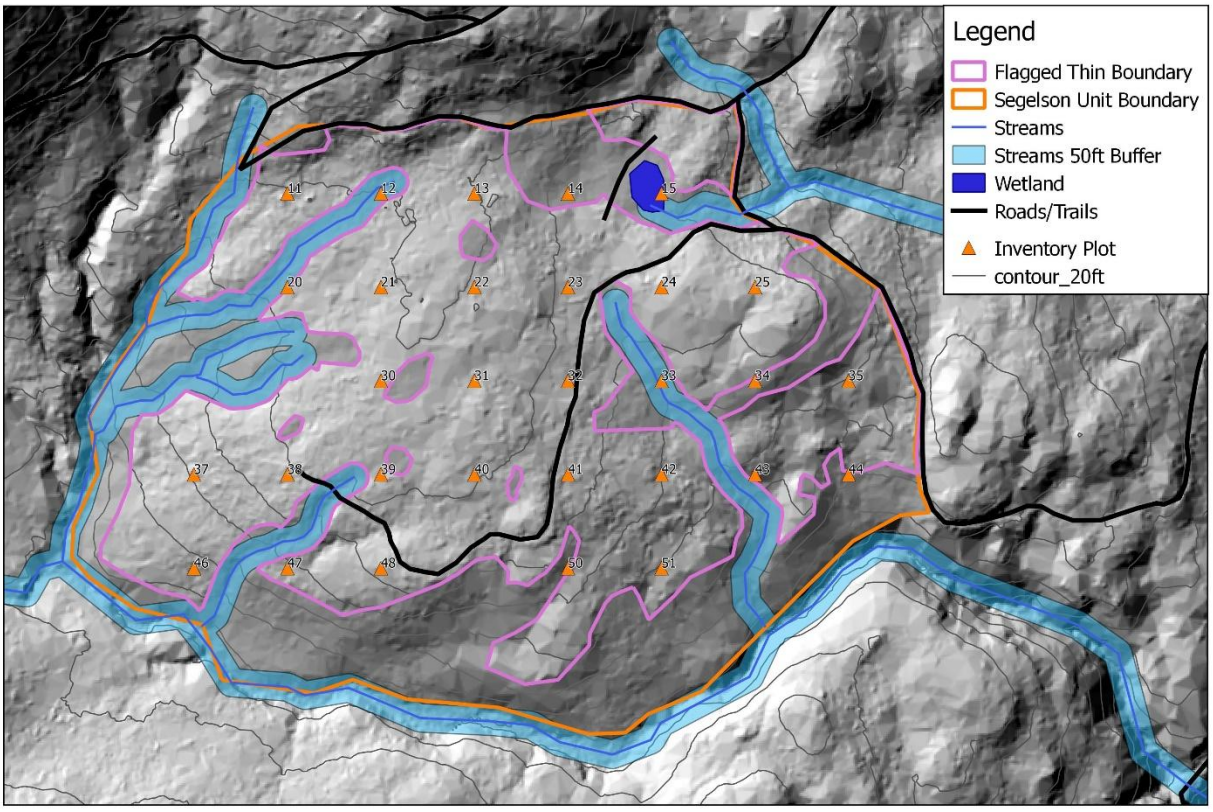
Gross volume (not accounting for log defects) for the stand averages 61 thousand-board-feet (MBS) per acre (14% error). However, silver-fir has a high proportion of frost crack trees, which will reduce the merchantable volume of wood. See table 2 for a breakdown of volume by species.

Table 1: Unit summary. 95% confidence intervals are in parentheses.

TPA	TPA GT 8"	QMD	QMD GT 8"	BA	BA GT 8"	SDI	Curtis RD	Gross Volume	Live Crown Ratio	Height-Diam. Ratio
375	267 (32)	13.3	15.0	353	340 (38)	566	97	60.9 (8.2)	39%	80

GT 8": Calculation using only trees that are greater than 8"dbh

Figure 1: Topography with inventory and monitoring plot locations in the Segelsenstand.



Mount Baker - Snoqualmie National Forest Collaborative
Segelsen Pilot - Plot Locations

0 250 500 750 1000 ft

Scale 1:5,000

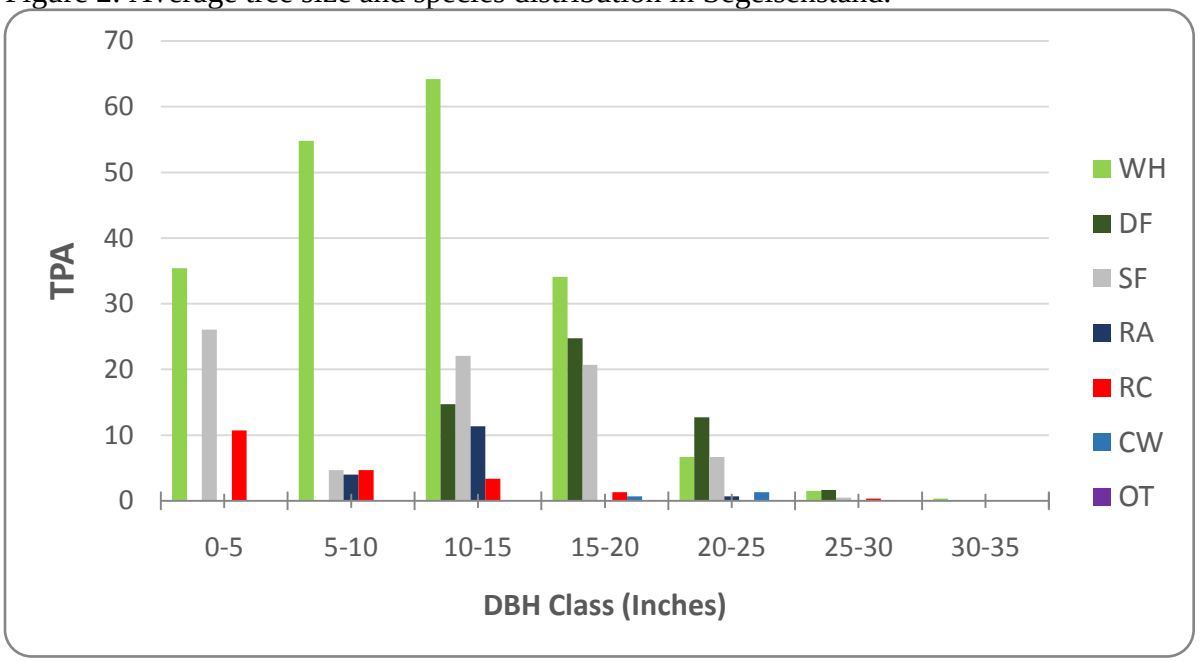
North

Live crown ratio (LCR) is a good measure of tree vigor and ability to respond to thinning, with crowns 40% or greater correlating to healthy, well-growing trees. Live crown ratios are low to moderate, averaging 39% and ranging from 22-66%. Dominant trees have higher LCRs while suppressed trees have poor LCRs. Height to diameter ratio(HDR) is a good measure of treestability. HDR greater than 70-80 indicate trees that are prone to toppling in wind and ice storms, especially if the stand is opened up through thinning.Average HDR is 80 in this stand. However, the dominant and codominant trees tend to have wind-firm HDRs less than 80. These trees will be the retention trees in a thin, minimizing wind damage post-thinning. The understory is poorly to moderately developed. The majority of the stand has few or no understory plants. Regeneration of western hemlock and silver fir is sparse in most places, but dense in gaps. Where understory vegetation does occur, it is dominated by sword fern and vine maple, as well as salal in some areas. Moderate amounts of downed logs are present (3-10% cover), including occasional very large old-growth legacies. Snags of recent density-dependent mortality occur at a rate of 59 per acre, ranging in diameter from 5 to 20 inches. Infrequent legacy snags from the past old growth stand also occur. Windthrow and laminated root rot have created a few small openings though generally the forest canopy is consistent. Bear damage, dwarf mistletoe, and stem breakage from snow, ice, and wind have created a low number of green wildlife trees, or trees with defect. A number of large western hemlock (20-25” dbh) exist that have significant dwarf mistletoe platforms (Fig 3c). These exist mainly in groups of 2-5 trees, but individuals also exist in a few places. Lower platform branches are being shaded out by surrounding trees in most cases.

Table 2: Species summary for Segelsen plot project.

Species	**TPA**	**BA**	**QMD**	**SDI**	**Gross Volume (MBF)**
Western hemlock	198	153	11.9	253	22.5
Douglas-fir	54	96	18.0	146	21.5
Silver fir	83	78	13.1	124	13.9
Red alder	16	11	11.4	20	1.5
Western redcedar	20	8	8.6	14	0.6
Cottonwood	2	5	20.5	7	1.0
Other	0	0	-	0	0.0
Total	**375**	**353**	**13.1**	**566**	**60.9**

Figure 2: Average tree size and species distribution in Segelsenstand.



WH = western hemlock, DF = Douglas-fir, SF = silver fir, RA = red alder, RC = western redcedar, CW = cottonwood, OT = other species

Figure 3a: Common stand conditions in Western Hemlock dominated areas.

Figure 3b: Common conditions in Douglas-fir dominated areas.

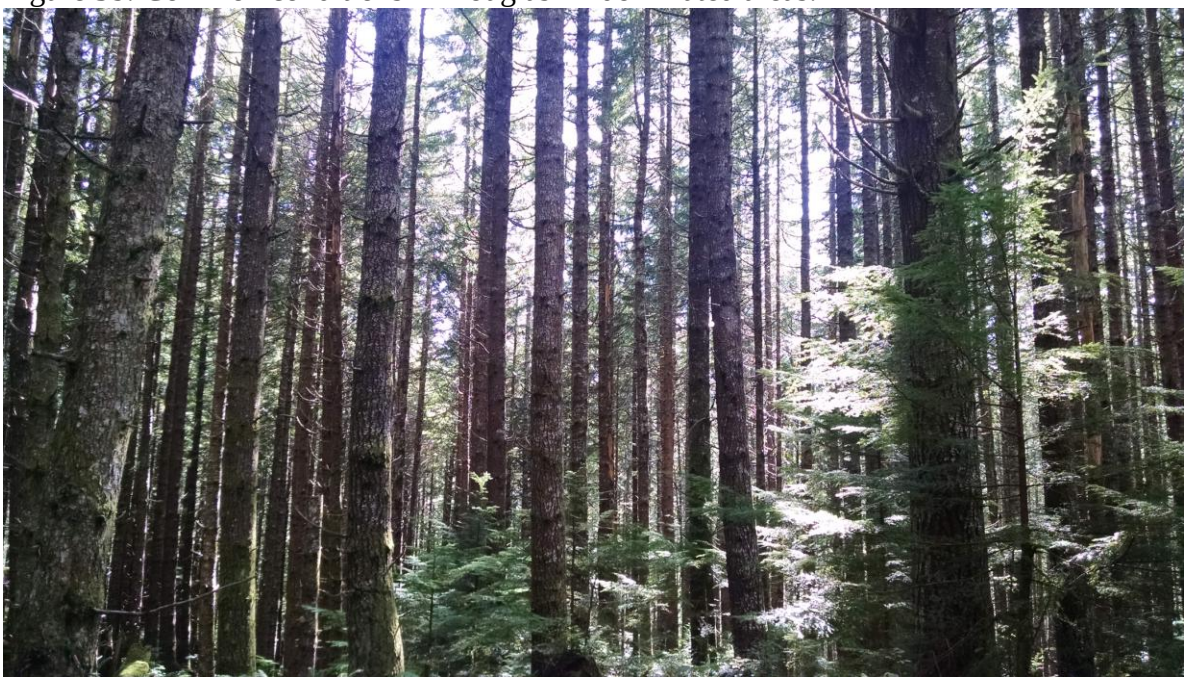


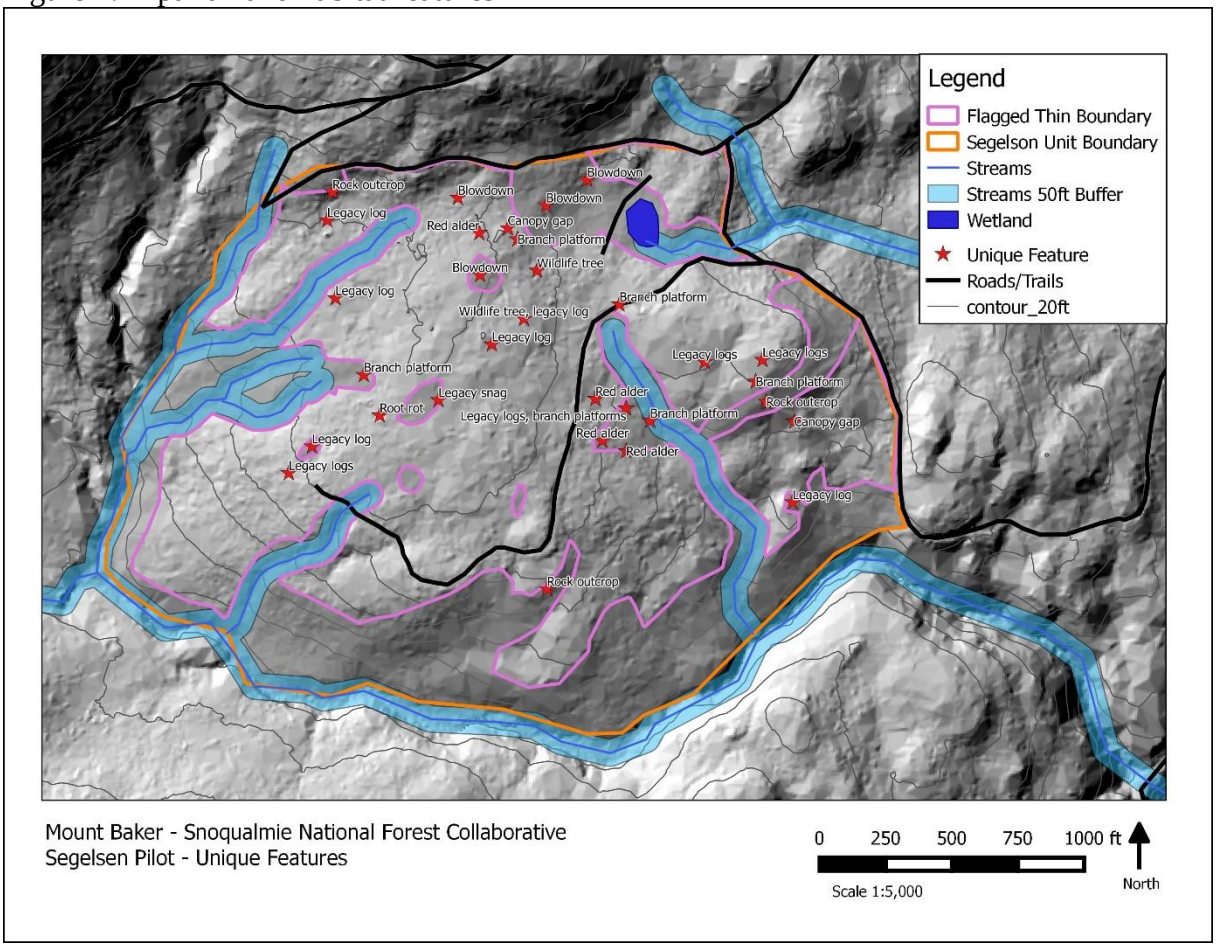
Figure 3c: Western hemlock with dwarf mistletoe platform. These are rare within the stand.

Riparian and Habitat Features

Over several site visits in the fall of 2015 and early winter of 2016, sensitive features were identified in the Segelsenstand. These included streams and wetlands, large trees with mistletoe branch platforms, rock outcrops, and other important biological resources. Other important habitat features were also assessed, includingwildlife trees (green trees with broken or forked tops, bole decay, branch platforms),legacy snags and downed logs, and blowdown patches.

The stand is within the Segelsen Creek-North Fork Stillaguamish River watershed (HUC 12); Hydrologic features drain into North Fork of the Stillaguamish River. A number of intermittent streamsand one wetland occur within the stand but no perennial streams were observed in September of 2015. All streams were field verified and thoroughly mapped in January of 2016. A LiDAR ground model and hillshade greatly assisted in this effort. All streams within the stand were classified as seasonal, non-fish bearing streams. The stand borders Cascade Creek to the south, which is classified as a perennial non-fish bearing stream per the District Fish biologist.

Figure 4: Riparian and habitat features



IV. Desired Future Conditions

The long-term desired future condition is forest structure and habitat characteristics associated with late successional/old growth forest. Desired characteristics include a patchy, multilayered canopy with a high degree of crown closure and trees of several age classes. The overstorywill include large diameter trees (exceeding 36 inches DBH) with broken tops and other indications of old and decaying wood in some individuals. Dominant and co-dominant trees will have HDR of 60 or less, and LCR of 50% or greater. The understory would include a variety of herbs and shrubs on the forest floor, and trees with a range of diameters and ages. Levels of coarse woody debris would range from moderate to high (10-15% ground cover), and there would be at least 4 large snags per acre (over 20 inches DBH and 15 feet tall). Given climate change projections, shifting species composition toward more drought and fire tolerant Douglas-fir and bigleaf maple, and to a lesser extent western redcedar, is desired. Silver fir and western hemlock are less likely to persist over time.The stand is currently moderately diverse, so retaining vigorous Douglas-fir, western redcedar, and hardwoods while favoring removal of western hemlock and silver fir will promote the desired future conditions.

V. Silvicultural Prescription

The 113 acre Segelsenstand will receive three different treatment types to achieve variable densities: skips, gaps, and thin areas (Figure 5). Only 65 acres will be treated with commercial wood removal.

No entry skips and buffers (47 acres, 42% of unit):

Skip areas will protect riparian features;provide for small diameter snag recruitment; protect large downed logs from mechanical disturbance and drying out from changes in microclimate post thinning; create refugia for species negatively impacted by thinning (fungi and some arthropods, small mammals, birds and amphibians); and facilitate the development of a more complex, patchy canopy post thinning by creating contrasts in the light environment throughout the stand. Skips should range in size from small to medium sized patches (0.1 – 1 acre) to large un-treated buffers on wetlands, streams, or on steeper slopes. Skips include patches located within the thinning area and areas excluded from thinning by unit boundary placement.

The original boundary of the unit is considerably larger than the 65 acres selected for commercial wood removal. Approximately 42acres of the original stand area are excluded from the harvest unit.

These acres include 50-foot minimum riparian buffers on streams and wetlands, an additional a 30-foot no-cut buffer from the edge of slope break of all inner gorges and unstable slopes near Cascade Creek, and areas with consistent slopes greater than 35%.

An additional 5.5 acres of external skips were located on the edges of the flagged boundary and thus were flagged out of the unit boundary. These are areas that could have been thinned, but had biological hotspots such as hardwood patches, gaps, concentrations of old-growth legacy dead wood, and groups of larger hemlock with dwarf mistletoe platforms. Finally, small internal skips (1/4 – 0.5 acres total of 1.5 acres) have been flagged out within the unit boundary to protect similar features and to break up areas of thinning with dense patches.

Gaps:(7 acres, 6% of 113 acre stand, 10% of commercial unit)

Two types of gaps will be created. The first type are true canopy gaps where no trees will remain. These gaps will stimulate understory shrub and tree regeneration and provide locations to plant western redcedar and bigleaf maple.True canopy gaps were located in structurally simple areas with few large trees or trees with major branch platforms. The second type are release gaps where vigorous Douglas-fir, western redcedar, and bigleaf maple will be released by heavy removal of competing trees. These gaps will promote the development of very large trees with deep crowns and major branch platforms. Also, some gaps have a significant understory shrub layer, while others do not. This will allow for monitoring of the effect of pre-treatment shrub presence on post-treatment hemlock regeneration.

A total of 16 gaps have been flagged out that range from ¼ - 0.9 acres in size.Five of the 16 gaps are larger than ½ acre. Two methods were used to lay out gaps: (1) Trees on the perimeter of gaps were flagged. (2) A desirable center retention tree was flagged and a fixed radius assigned to that gap. Additional trees were then marked for retention in some gaps. All silver fir, western hemlock, and Douglas-fir will be cut with gaps, unless marked for retention.

Thinning Area: (65 acres, 57% of 113 acre stand)

This area will be thinned to an averageof 35-40% relative density. Two densities levels weredesignated based on forest type; Douglas-fir dominated areas will be thinned to an average of

130 BA (ft^2/ac) and the hemlock-silver fir areas to 150 BA (ft^2/ac). This equates to 40-45% BA retention. Tree retention will favor Douglas-fir, western hemlock, and then silver fir. All other species will be retained. Thinning will be primarily from below, selecting for healthy trees with vigorous crowns. However, large western hemlock with significant dwarf mistletoe brooms will be retained along with interlocking trees, in addition to 5-10 green wildlife trees per acre. A range of small, medium, and large clumps will be retained to create fine scale variability within the thinned area and to promote subsequent variability in understory tree and shrub response. See cutting guidelines below for the full list of tree selection criteria.

VI. DxPCutting Guidelines

The Segelsen thinning unit will be sold as a Stewardship sale utilizing a Designation by Prescription (DxP) contract.Harvest boundaries, skips, and gaps have been flagged (Figure 5). The sale administrator will explain these guidelines prior to cutting. A sample area has also been marked. These guidelines may be further refined to reduce complexity. However, none of the density levels or diameter thresholds will be changed. A figure will be included to visualize the variable pattern.

A. Guidelines for commercial thin areas outside of Skips and Gaps

1. Leave the following Basal Area (BA) using a BAF factor of 20:
    a. An average of 120 ft^2/acre in DF dominated areas, defined as areas where 1/2 of pre-harvest trees >8" are DF.An average of 150 ft^2/acre in rest of unit.
    b. At individual plots, residual BA may range from 40-260 ft^2/acre.
    c. All trees >8" dbh should be counted in BA.
    d. Ignore large clumps (#3) in BA counts
    e. Even or minimum spacing is not desired.Focus on leave tree criteria over spacing.

2. Leave and Cut tree criteria
    a. Cut and remove only western hemlock (WH), silver fir (SF), and Douglas-fir (DF).
    b. Only cut trees > 8" dbh and < 21" dbh for DF (23" diameter at root collar) and 24" for WH-SF (27" diameter at root collar)
    c. Thin generally from below, with the following criteria:
        i. Preference for removal:**silver fir > western hemlock >Douglas-fir**
        ii. Leave larger trees with healthy crowns
        iii. Thin variably leaving a mix of individual trees and small clumps (3-5 trees).
        iv. Leave WH >20" DBH with large dwarf mistletoe (DMT) platforms. Leave additional trees around DMT tree with interlocking crowns.
        v. Leave 5 to 10 wildlife trees per acre, defined as > 15" dbh live trees with clearly broken or forked tops, bole scars larger than a hard hat, mistletoe, or trees with frocks cracks resulting in > 50% defect.
        vi. Retain snags as much as possible given the need for operator safety.

vii. Items 2.c.iv, v, & vi can be largely accomplished by clump retention (#3)

3. Leave 60 medium and large clumps
   a. Clumps are defined as trees within 12' (face - face) of at least one other tree in the clump.
   b. Exclude clump trees from basal area targets.
   c. Approximately ½ of the clumps should have 6-9 trees and ½ should have 10-15 trees.
   d. Medium and large clump trees should be painted by the contractor to facilitate cutting and compliance. GPS clump location and record the number of trees in each clump.
      i. Target large trees (>18" dbh) with complex crowns, mistletoe platforms, or defect for clumps. Some clumps may be located in areas with small trees (<18" dbh).
      ii. Smaller trees can be left or thinned out of the clump.
      iii. Large snags or downed wood concentrations are good locations for clumps
      iv. Clumps should be well distributed, but can be concentrated in some areas.

B. Guidelines for Gaps.

1. Gaps with posted/painted perimeter: remove all WH, SF, and DF unless painted pink. Retain all other species.
2. Gaps with painted center tree (double band of pink): Retain center painted tree + other painted trees (pink bands). Remove all other WH, SF, and DF within specified radius.

C.Flagging& Paint

1. Harvest boundary: Flagged in light pink flagging.
2. Internal skips: perimeter trees are marked with pink flagging. Retain skip perimeter trees.
3. Temp road centerlines are flagged with pink.
4. Gaps: perimeter trees are marked with blue flagging. Retain gap perimeter trees.
5. Center gap trees: double blue flagging (will be replaced with double band of pink paint)
6. Retention (no-cut) trees: single band of pink paint.

VII. Post Treatment Planting and Site Prep

Plant 95 TPA red cedar and 5 TPA of bigleaf maple in canopy gaps greater than about ¼ acre in size. Protect western redcedar from deer browse. Annual manual shrub control may be necessary until planted trees reach above shrub height. Additional site preparation is not necessary. The Collaborative may enlist the help of STEM students for tree planting, maintenance, and monitoring. Gaps less than ¼ acre are too small for planted trees to experience substantial growth. Natural regeneration of western hemlock and silver fir will densely infill the smaller gaps.

VIII. Forest Operations and Logging Systems Plan

In coordination with Collaborative members and Forest Service staff, a forest operations and logging systems plan was developed in protect important resources (Figure 6). Steep slopes greater than 35% slope for pitches longer than approximately 100 feet are excluded from the harvest boundary. Six landings are under consideration: one on the main access road to the unit, and five landings distributed along the temp road to optimize yarding distances and slope considerations. Appropriate logging equipment include combinations of the following ground-based systems: forwarder, processor, feller-buncher, skidder and/or shovel yarding, hand-falling on steep pitches, or other equipment approved by the Forest Service.

- Ground-based equipment is excluded from slopes >35%,
- Directionally hand-fall trees on short pitches of slope >35% and recover using equipment on adjacent moderate terrain.

Access Roads

Existing non-systemroads need to be improved for logging truck and equipment access. These roads have solid gravel base and were not put in storage after use circa 1950. They have not recovered ecologically with only shrubs and small trees growing on the road surface and a number of undersized, failing culverts still in place. The subgrade is generally sound but may need repair, and will need a new layer of surface rock in places. Work required to prepare these roads for haul could include clearing, brushing, grading, ditch cleanout, and potentially drainage improvements, spot rock, and subgrade repair in some areas.Two road segments will need to be improved.

Unit Access Road

Approximately 2,868 feet of existing gravel-baseroad from the original harvest will need vegetation clearing, grading, and drainage improvements to gain access from Forest Road 18 to the temporary logging access road that goes into the unit. After logging, this unit access road will be put into storage, where vehicle access is blocked and the road is left in a hydrologically stable condition. Storage activities after the thinning activities would include the removal of the culvert on a perennial stream just beyond (north of) the junction of the access road with the temporary road. While this portion of the access route may not be utilized in the thinning activity, the culvert is old and undersized and would be removed as part of the stewardship needs for the areas. Since the access road would likely be used for future harvests on adjacent units to the north (Figure 6), the road will

be hydrologically stored with a standardized closure berm at the junction of the access road and Road 18.

Temporary Road

Approximately 2,482 feet of existing gravel-base road from the original harvest extends into the unit from the access road. This road requires vegetation clearing, grading, and drainage improvements. After logging operations are complete, this road would be decommissioned, with the potential for the road prism to be used in 20-30 years if a future thinning entry takes place.

Figure 5: Flagged boundaries and skips and gaps.

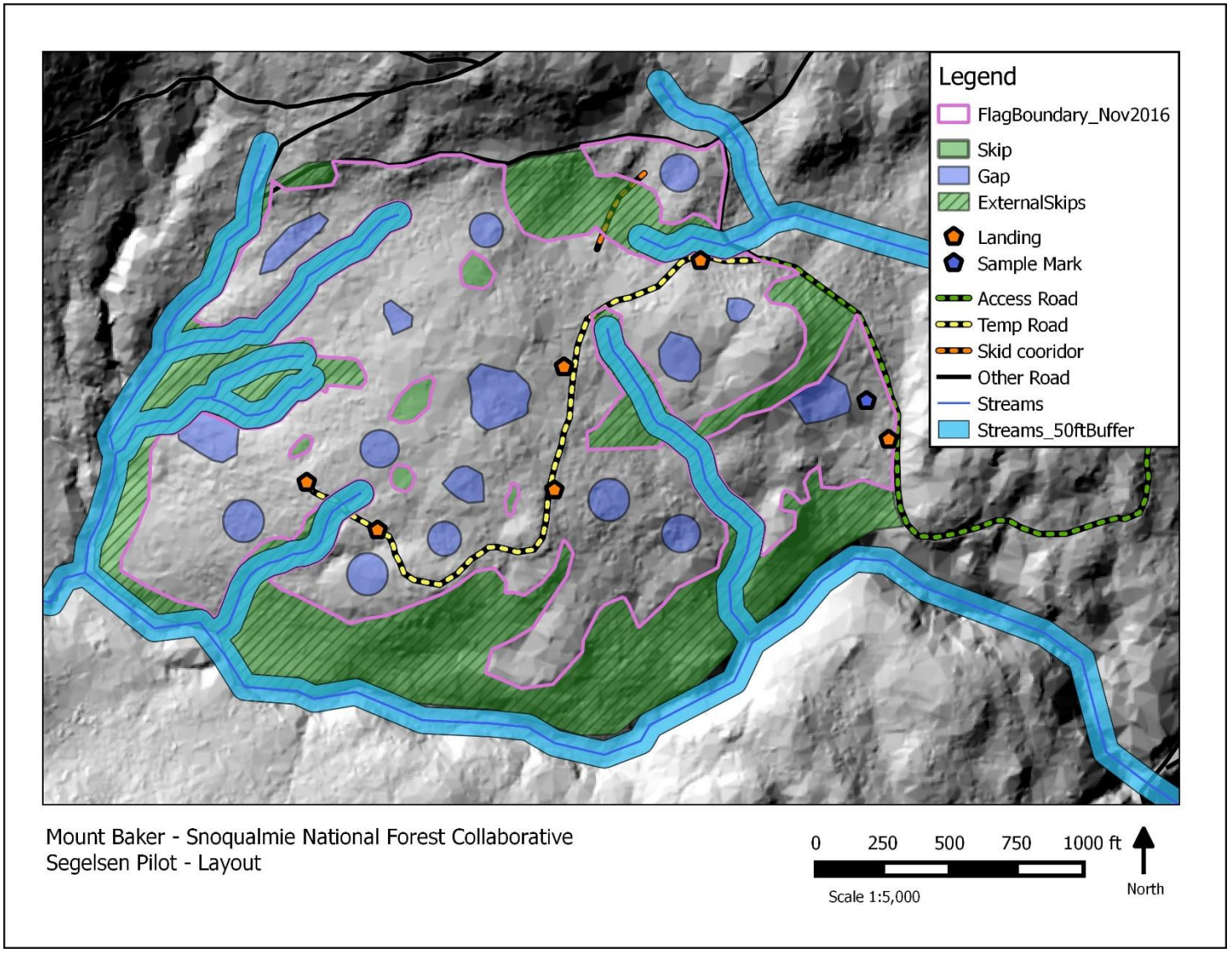
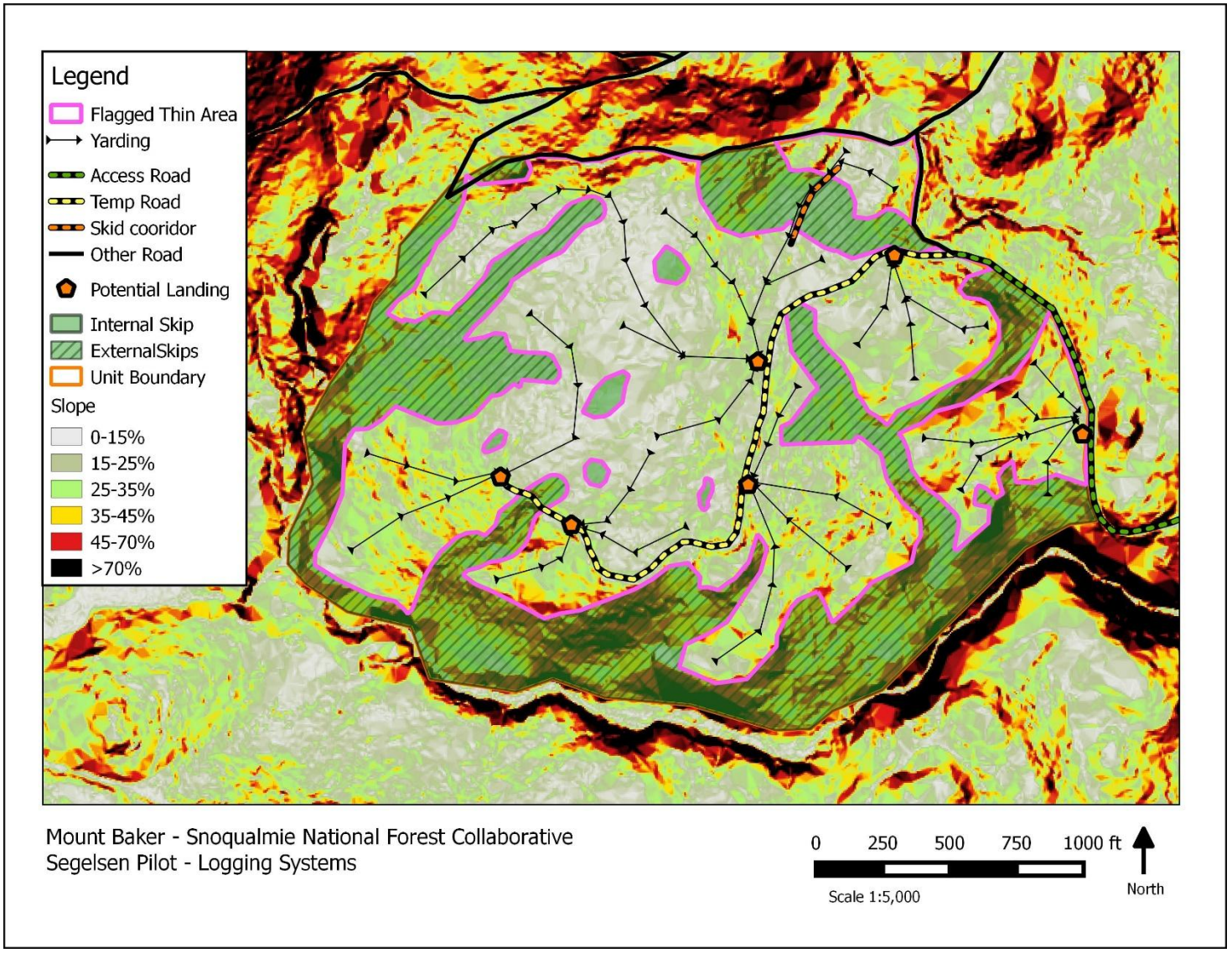


Figure 6: Logging systemsand road access plan.



IX. Monitoring Plan

Three kinds of monitoring will be undertaken:

1. **Compliance monitoring**:

   Collaborative members will work with USFS staff to assist with compliance monitoring of key contract elements, including the DxP prescription and road work. The goal will be to ensure that operators understand goals of treatment and are implementing them effectively. USFS staff are responsible for contract compliance.

2. **Effectiveness/ecological monitoring:**

   Thirty stand exam/inventory and long-term monitoring plots were established throughout the Segelsen pilot project unit (Figure 1). Plots were GPS-located, monumented with a durable PVC center stake, and include a bearing tree from which plot center can be re-located using compass bearing and distance. This allows repeat measurements post-thinning to monitor the project's outcomes over time. Plots are $1/20^{th}$ acre fixed-area plots measuring all trees above breast height (4.5 feet from ground, DBH), with ground vegetation sampling, and sub-samples of tree heights, ages, diameter growth increment, and live crown also measured. Additional transects for downed wood may be installed. These plots will be re-measured after treatment and periodically thereafter to assess forest conditions and alignment with the desired future conditions of the treatment area.

   These monitoring plots will allow us to address the following questions.

   - Does thinning accelerate the development of large trees with complex crowns, including platform development?
   - What are the most resistant trees species to mortality from windthrow, pathogens, and drought stress? Are mortality rates higher for WH and SF relative to other species?
   - Does thinning result in a uniform carpet of WH regeneration, or does a more variable thinning treatment result in variablepatches of hemlock regeneration and other tree species and understory plants?
     - Does higher pre-treatment understory shrub and herb cover reduce western hemlock regeneration, especially in gaps?

    - Where and how much western redcedar, Douglas-fir, and broadleaf tree regeneration occurs?
- What is the change in cover and diversity of non-tree, understory plants?
    - Does thinning introduce invasive weeds?
- What is the impact of thinning on snag density, as well as downed wood if transects are installed?
- How fast does the canopy reclose after thinning, particularly to levels associated with Northern Spotted Owl nesting-roosting-foraging habitat and Marbled Murrelet habitat?

3. **Economic/implementation monitoring**

The following items will be monitored

- Volume outputs and workdays/wages created.
- Time and costs of implementing DxP approach for layout crew and contractor.
- Time and costs of monitoring.

X. Approval

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Approved by: _____

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